Minutes of TRB Superpave Asphalt Binder
ETG Meeting of September 27 & 28, 2004
Washington, D. C.

A joint session was held between the Superpave Mixture & Aggregate and Asphalt Binder Expert Task Groups on September 27, 2004. This joint meeting was held at the National Academy of Sciences in Washington, D.C. Mr. Neil Hawks gave a welcoming address. Following items were discussed in the joint session:

1. Neil Hawks briefly highlighted the current challenges, meeting expectations and meeting logistics.
2. John D’Angelo discussed the current challenges in an uncertain environment.
3. Ed Harrigan reviewed the on-going NCHRP projects.
4. Rick Harvey gave an update on AASHTO sub-committee on materials which included the status of current changes to specifications.
5. John Tenison gave an overview of current activities of the Binder ETG and expected time line to complete the ongoing projects.
6. John Bukowski presented the current activities of Mixture and Aggregate ETG.
7. Linda Mason briefed the activities of Communications ETG.

Superpave Mixture & Aggregate and Asphalt Binder ETG continued the technical discussions independently on September 27, 2004 in the afternoon hours.

Topics of technical discussion discussed in Superpave Asphalt Binder ETG meeting were as follows:

- High Temperature Task Group Report
- Low Temperature Task Group Report/Discussion
- Update on the Asphalt Binder Aging
- Acid Modification - General Group Discussion of State/Industry Concerns,
  - Review of FHWA Proposed Research
- Report on Fatigue Task Force
- Binder Aging
- FHWA ALF Activities – Report and Discussion
- Other Issues Identified by Participants
- Closed Session - TRB Asphalt Binder ETG members only.

**John Tenison (NMDOT – ETG Chairman)** welcomed the members and participants to the meeting. He opened up the technical discussion with LTTP Bind Software evaluation. In the last ETG meeting, a few copies of LTTP Bind software (beta version) were circulated to the State DOT’s and other agencies for evaluation. Some members had problems with the software and some were able to evaluate the software. Gayle King expressed concern about the High Temperature grade selection for Arizona. John D’Angelo demonstrated the new LTTP Bind software version 3.0 showing the high temperature selection in the Arizona area represents close to what is being used in those areas. In addition, he recommended that the Arizona DOT should look into using modified systems to avoid age hardening problems instead of the neat asphalts. Consensus of the group was to forward the new High temperature Grade selection program to AASHTO for consideration. The LTTP Bind Version 3.0 software can be downloaded from the
following website for evaluation:

[ftp://fhwaftp.fhwa.dot.gov]
User ID: hiptguest
Password: hiptguest

The files are located under this directory:
[ftp://fhwaftp.fhwa.dot.gov/HIPT/TO/LTPPBind 3]
If you have problems retrieving the files or not able to access them, please contact John D’Angelo, FHWA at 202-366-0121 or email him at John.D’Angelo@fhwa.dot.gov

Additional site to download the files is
[http://ltppbind.com/]
This site will contain a zip file for installation.

Action: John Tenison, ETG chairman will send a notice to the AASHTO SOM members by email notifying them about the location of the new software. The ETG recommends its adoption by the AASHTO SOM.

Gerry Reinke (Mathy Construction – WI) presented results from a study entitled “Binder Rheology and Its Relationship to Mixture Rutting”. The objective of this study was to obtain Rheological characteristics of the binders that strongly correlate to the rutting behavior of the mixtures in the Hamburg Wheel tracking test. The study included six PG 64 binders with a single Superpave mix design for a traffic level of 1 million ESAL’s. The asphalt binders included a control PG 64-22 and five PG 64-34 binders produced with a variety of polymer and additive types. Rut testing was conducted on mixture specimens at a minimum of three temperatures for each binder utilizing the Hamburg wheel-tracking tester operated in dry mode. Temperature frequency sweeps of mixture slices were conducted using the dynamic shear rheometer and a variety of rheological tests were performed on the unaged and RTFO aged binder samples for each mixture. Rut depths were collected at 5000 and 10000 passes. The conventional parameter G*/sinδ at 10 rad/s, complex viscosity, η* and η’ at 10 Hz were collected on unaged and RTFO aged binders for each mixture. Rut depths were collected at 5000 and 10000 passes. The conventional parameter G*/sinδ at 10 rad/s, complex viscosity, η* and η’ at 10 Hz were collected on unaged and RTFO aged binders. He showed several different comparisons of these rheological parameters to the mixture rutting. It was found that the G*/sinδ did not correlate well with the rutting behavior but it was found that the complex viscosity, η* of the RTFO residue provided a good correlation to mixture rutting. Complex viscosity, η* of the RTFO residue obtained at 1000 Pa stress was also well correlated to mixture rutting.

Discussions were focused on the speed of testing in the rut tester and dynamic shear Rheometer after his presentation. Hussain Bahia was concerned about the rational of using a viscosity parameter to predict the rutting performance in the field using the rut tester. Gerry Reinke reiterated that this experiment was to find a rheological parameter that correlated to rutting and suggested looking at these rheological parameters in actual traffic situations.

John D’Angelo (FHWA – DC) presented the preliminary test results from the Creep Recovery
experiment. The purpose of this study was to evaluate the high temperature criteria for rutting in the asphalt binder specification. He discussed the disparity between binder PG grade and rutting tendency of mixtures produced with those binders in the laboratory rut tester. The Creep & Recovery testing (1s-loading and 9s-recovery) at various stress levels and at different temperatures were conducted on several different asphalt binders including heavily modified asphalt binders. Multi stress Creep & recovery was also conducted at 25, 50, 100, 200, 400, 800, 1600 & 3200 Pa stress levels. The test results from multi stress creep recovery tests were compared against the test results at individual stress level and the results were found to be the same. It was found that, the multi stress creep recovery test could be used to identify, if the heavily cross-linked materials experience any slippage at high stress levels. Initial results indicated that the asphalt binders are stress dependent. The non-recoverable compliance seems to be a good indicator for identifying the asphalt binders, which are more sensitive to stress conditions. The asphalt binders, which are more sensitive to higher stress levels, should be avoided in the field as some binders at higher stress levels exhibit shear-thinning behavior. Testing on several ALF, binders have been completed. Testing on additional binders is being conducted to evaluate and arrive at the high temperature specification criteria that can be related to the field conditions. Discussions will continue at the next meeting.

John Casola suggested using the strain levels (from strain sweep testing) to see if there is any relationship to the rutting performance. Dave Anderson expressed his concerns about the lack of field study to verify the laboratory research work and ETG should consider having more field studies to verify the laboratory findings. Hussain Bahia suggested the use of two-stress levels in the specifications, if the binders are so sensitive to stress levels. John D’Angelo said that, it becomes difficult to include two levels, as some of the binders are not that sensitive to stress levels. Discussions are expected to continue at the next meeting.

John D’Angelo (FHWA – DC) reported that a research study would be conducted by the FHWA in the near future related to the concept of reserve strength in asphalt binders at low temperatures. Aroon Shenoy, FHWA will put together an experiment plan soon and report the status at the next meeting. The purpose of this study is to evaluate the effects of fracture strength of asphalt binders at low temperatures well above the critical cracking temperatures including the traffic loading. Comparisons of thermal stresses development against the strength of the binders indicate that there is large differences between binders with the same T_{cr}. These differences in the binders fracture strength, might give an indication of improved crack resistance at temperature above the T_{cr}.

Sang-Soo Kim (OSU) provided an update on Asphalt Binder Cracking Device (ABCD). The ABCD is the new low temperature-cracking test equipment developed by Sang-Soo Kim from Ohio State University, which measures the cracking temperature of asphalt binders directly. This test is a direct measurement of the cracking temperature of the asphalt binder. The Asphalt Binder Cracking Device consists of a cylindrical asphalt specimen formed around a thin aluminum ring. The sample is cooled and as the asphalt contracts the stress is measured with a strain gauge, mounted inside the mold. An earlier study was conducted using the aluminum ring with a round specimen, which had problems with the repeatability. The recent study included silicone molds with holes in the specimen to create stress concentrations. Silicone molds were used to introduce in-homogeneity and minimize specimen handling. A thermal stress calculation program was developed similar to Tsar to
compare the theoretical and measured thermal stress from ABCD. Several polymer modified asphalt binders from the ALF study were tested in the ABC device using the refined procedure. Test results were compared with TSRST, MP1a, MP1, BBR stiffness and m value. Effects of CTE on asphalt binders, ABCD rings and aggregates were studied. Following conclusions were drawn from the study:

1. Silicone molds improved the repeatability
2. Polymer modified binder increased the strength in turn lowered the cracking temperature
3. ABCD highly correlated with TSRST
4. MP1a with ABCD strength correlated best with the TSRST
5. Theoretically calculated thermal stress agreed well with the measured thermal stress from ABCD
6. Effects of CTE were significant and need further evaluation.

A number of issues were discussed related to ABCD after his presentation. The important issues included:

1. The use of pavement constant 23 in the thermal stress calculation which was different from the Tsar program
2. Comparing the test data with TSRST, which is purely an empirical test
3. Size of the specimens being used in ABCD
4. Physical Hardening of asphalt binders
5. Strain rates compared to the DTT test method and how it compares in the ABCD.
6. Members were concerned about using the silicone molds in the ABCD, as silicone molds affected test results during the DTT development.

Action: Consensus of the ETG group was to look at the effect of silicone molds by comparing the strength data from the DTT. Sang-Soo Kim will reevaluate the above issues during the next few months and expected to report at the next meeting.

Tom Harman (FHWA – TFHRC) gave an update on “Understanding the Performance of Modified Binders in Asphalt Mixtures 67-80 Binder Study”. The work done under this study is overseen by the Binder ETG, Mix ETG and TWG. The purpose of this study is to validate new binders specifications with mix performance testing. The rutting factor $G^*/\sin \delta$ in the current specification captures the viscoelastic response but not the viscoplastic or the permanent deformation. This project was primarily the fatigue driven project; the rutting aspect of the study was presented at this time. The study was called 67-80 because the asphalt binder PG grades examined were ranged from 67 on up to 80. At the last meeting, the data presented included the asphalt binders with similar PG grade and ETG recommended to study at least two ranges of performance grade. He briefly discussed the research approach, asphalt binders considered in the study, the mixture characterization, proposed binder parameters, assessment of the current approach and preliminary evaluation of the proposed parameters. Test results from the Superpave Shear Tester (SST) tester and other laboratory performance tests including both mechanistic and empirical tests. The three tests were: cycles to 2% strain failure, strain at 5000 cycles and strain at 1000 cycles. It was found that the current superpave high temperature parameter does not appear to fully capture rutting potential based on the SST mixture response. Finally, he listed the following future steps that will be conducted under this
Terry Arnold (FHWA – TFHRC) presented the proposed work plan for the study of Phosphoric Acid Modification of Asphalt Binders. Acid modification has been shown to be a low cost way to increase the high temperature stiffness of asphalt binders. Currently there are no guidelines for State agencies on how acid modification of asphalt binders should be used. A detailed study will be conducted by FHWA to evaluate various aspects of acid modification. Terry discussed briefly the effects of acid modification, work done to-date and suggested methodologies of acid modification. The proposed work plan includes:

1. Forensic method of determining the type and level of phosphate additive
2. Durability of acid modification
3. Address corrosion and handling issues
4. Optimization of acid modification

Several issues were discussed concerning acid modification particularly, understanding the chemistry of acid modifications, mechanical tests to determine the effects of acid modification, performance of acid modified binders etc., Consensus of the group was to begin this study to identify the properties and tests of acid modification. Terry will provide an update/progress at the next meeting.

Hussain Bahia (Univ. of Wisconsin – WI) delivered a presentation on the fatigue of asphalt binders measured using parallel plate and torsion cylinder geometries. Previous discussions about the NCHRP 9-10 parallel plate fatigue testing raised concerns that the test was affected by flow at the edge of the specimen, which made the results invalid. The fatigue task group decided to evaluate the parallel plate fatigue test by using the Torsion Cylinder test. The hypothesis of this study was that, “the edge effects are important if the relationship between the parallel plate geometry and torsion cylinder are not the same”. The Torsion Cylinder procedure was introduced by Texas A&M University using sand mix specimens in 2002. He briefly explained the sample molds, and sample preparation. This study included:

1. Three Labs – FHWA, MTE, UW
2. 5 Asphalt binders – 2 Unmodified, 3 modified
3. 2 Temperatures – 25°C & 10°C
4. Two Geometries – Parallel Plate (PP), Torsion Cylinder (TC)
5. 3 Stress levels

All the required testing has been completed by the three labs. The presentation included the test results and the initial fatigue analysis based on dissipated energy ratio. The fatigue damage (Np20) is calculated numerically based on number of cycles to failure, where the G*/sinδ values drops by more than 20 percent from its maximum value. Volume ratio of PP/TC samples was used as a shift...
factor to compare the PP and TC test data. K1 & K2 relationships were used to compare the test data. Statistical analysis was conducted on the test data to determine the effect of variables and their interactions. The interim findings based on the initial analysis were listed and are as follows:

1. Normalizing the effect of modulus is important
2. Torsion cylinder modulus was much higher than the parallel plate modulus
3. Volume ratio appeared to serve as a good shift factor
4. Parallel plate appear to be more repeatable than torsion cylinder
5. There are many variables that effect repeatability in torsion cylinder

He summarized saying that all the data is available, the task group will meet to sort out the test data, clear some outstanding issues, complete the analysis and present the final report at the next meeting.

Discussions were focused on a number of issues specifically; the stress levels used for testing, the geometry, air voids in the specimen, size of Ottawa sand, and tests required to determine K1 & K2 using parallel plate geometry, equipment requirements and surrogate test methods. Hussain Bahia reiterated that the data analysis will be completed and recommendations will be provided by the Fatigue Task Group, whether to propose a surrogate test or continue to modify the TC to improve the repeatability. Consensus of the group was to complete the analysis. Hussain Bahia will provide a final report to the ETG. No action was taken.

Satish Ramaiah (FHWA – TFHRC) presented the preliminary test results from the Asphalt Mixtures Aging Study. This was part of a continuation study of Modified German Rotating Flask. The objective of this study is to:

1. Determine the effects of aging on bituminous mixtures using lab compacted gyratory specimens tested in Dynamic Shear Rheometer
2. Compare the short-term aging of Asphalt Mixture to Asphalt binder

The study included six asphalt binders, two aging conditions (Un-aged, 4 hrs aging at 135°C), two temperatures, and three replicates. Torsion specimens of 50x12x10mm cut from gyratory specimens were tested in Dynamic Shear Rheometer. Frequency sweep of 0.1 to 100 rad/s was conducted to determine the modulus of Asphalt Mixtures. The coefficient of variation ranged from 5 to 36 percent. Initial findings were as follows:

1. Preliminary test results indicated significant increase in the modulus on the aged specimens when compared with unaged specimens
2. There was a reasonable correlation between the asphalt mixture and asphalt binder short-term aging based on the aging ratio.

Discussions: Gerry Reinke suggested looking at the test data from unmodified binders, as separation is an issue with the polymer modified asphalt binders. Bob Klutz suggested aging compacted specimens in the molds rather that loose mix to reduce the testing variability. ETG was interested in looking at the comparison of the test data at 10 rad/sec from the torsion bar testing. No action was taken, however the testing on the remaining samples will be completed. Satish Ramaiah will report the final analysis at the next meeting.

Dave Anderson (AAT Consultant – PA) verbally presented an update on the status of NCHRP 9-36 – Improved procedure for Laboratory Aging of Asphalt Binders in Pavements project. This project was initiated in April 2003. Dave Anderson is the principal investigator of this project. The primary
focus of this project is to develop a short-term aging test method that has potential extendibility to long-term aging test. The short-term aging will be based on physical properties as opposed to chemical properties. The main objectives of this project was to:

1. Identify promising candidate methods
2. Develop statistical design of a laboratory experiment
3. Conduct the laboratory experiment
4. If successful, prepare an AASHTO test method
5. Recommend an experiment to extended the method to long-term aging.

He discussed the selection study that was conducted to arrive at short-term aging methods with pros and cons. The Stirred Air Flow Test (SAFT) & Modified German Rotating Flask were selected as the candidate methods. These two methods were modified further to evaluate for long-term aging. Several different modifications of the two methods were tried to determine which was best suited for both the short-term and long-term aging. Based on the evaluation the SAFT was considered as the best potential test for both short-term and long-term aging. A recommendation has been forwarded to the NCHRP panel to proceed with the SAFT. If the panel approves, the study will be continued with SAFT. The final phase of this study would be to compare the binder and mixture aging. His presentation will be available with the minutes Dave Anderson will provide a progress report at the next meeting.

**Gale Page (FLDOT)** Brought up an issue about recycling of asphalt pavement. Testing in Florida indicates that the existing binder in the pavement is much stiffer than originally believed. In addition to this stiffer binder are being used in the production of the new rap mixes. The State is concerned that the binders will be too stiff and may have problems with fatigue and low temperature cracking.

ETG suggested testing the low temperature properties on those binders that are in question, which will give better control over the type of asphalt binders acquired.

**Gaylon Baumgardner (Paragon)** brought up an issue of PG 67-22 asphalt binder. GA DOT along with most of the southeast has adopted a PG67-22. When GA DOT implemented these specifications, they did not change the intermediate temperature specifications from a PG 64-22. This makes it difficult to meet the intermediate temperature of 25°C and still produce a 67 grade. Most Southeastern states FL, LA, MS, TN and AK have implemented 26.5°C as the intermediate temperature for 67-22. Peter Wu, GADOT was willing implement 26.5°C; however he wanted get the opinion of the ETG. Gaylon suggested using 26.5°C as testing temperature, which not only satisfies the superpave specifications but also solves the problem with the lighter crude producing PG 67 binders. Gaylon asked the ETG if there are any major issues in implementing the 26.5°C.

The ETG discussed this and felt that the 67-22 could be classified as a standard grade and not a bumped grade. This would allow the intermediate temperature to be \((67 - (-22))/0.5 + 4\) degrees or 26.5°C.

In the executive sessions, the members considered the following action items:

1. HTTG will continue to look at refining the John D’Angelo’s non-recoverable compliance approach and Gerry Reinke’s viscosity approach to arrive at the high temperature specification criteria that will work for both neat asphalt and modified
asphalts, including the field validation. Performance data from Nevada test sites; ALF data, Mississippi test sites and data from Gaylon Baumgardner will be used for field validation. Test protocol for both approaches will be available for the ETG to review. HTTG is hoping to make recommendations to SOM by the next two to three meetings.

2. LTPP Bind will be forwarded as a recommendation for selecting the high temperature grade and grade bumping to AASHTO

3. FHWA will start the evaluation the reserve strength concept in asphalt binder at low temperatures

4. A new study on acid modification study will be conducted by FHWA. FHWA will conduct the acid modification of PG 64-22 binder from different crude sources for evaluation. AI will help gather all those binders.

5. The Fatigue task group will meet before the next meeting, complete the data analysis and submit a report to the ETG. Initial review will be done at the next meeting. Future directions will be made after the review.

6. NCHRP 9-36 project will continue their work after the panel approval.

7. The PG 67-22 binder grades in southeastern region were considered as a Superpave PG grade but not as a bumped grade.

8. Future research projects were discussed – Intermediate Temperature durability problems & problems with RAP.

9. Individual task groups will meet in between ETG meetings, if necessary.

The details of the next Superpave Binder ETG meeting will be sent via e-mail to all the members and participants later.